SPATIAL VARIATIONS OF THE WAVE, STRESS AND WIND FIELDS IN THE SHOALING ZONE

Jielun Sun
Program in Atmospheric & Oceanic Sciences
University of Colorado
Campus Box 311
Boulder, CO 80309-0311
Ph: (303) 497-8994, E-mail: jsun@ucar.edu

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LONG TERM GOALS

The long term goals are to improve parameterization of surface fluxes in the coastal zone in the presence of wave growth, shoaling, and internal boundary layer development. These goals include improving the present form of similarity theory used by models to predict surface fluxes and stress over water surfaces and to document development of internal boundary layers in the coastal zone which are currently not modelled correctly, particularly in cases of flow of warm air over colder water.

OBJECTIVES

The objectives are to provide quality controlled data sets which include spatial variation of surface fluxes, stress and wave characteristics in the coastal zone and vertical structure of the wind and thermodynamic variables in the coastal zone. The objectives also include evaluation of present formulations for surface fluxes at the air-sea interface and evaluation of model simulations of internal boundary layer development.

APPROACH

The first approach is completion of an extensive literature survey on existing studies of air-sea interaction in the coastal zone and internal boundary layer development. The second approach is implementation of three field programs, one in fall of 1997 and two in 1999. Two of the field programs will be located at Duck, North Carolina. The site for the third field program in late spring of 1999 has not yet been determined. The spring 1999 field program is designed to study the internal boundary layer in offshore flow, particularly in stable conditions. The third approach is data analysis and evaluation of existing boundary layer and surface flux formulations. The fourth approach is model comparisons in cooperation with Jim Doyle and Jack Glendening at the Navy Research Laboratory.

WORK COMPLETED

a) Experiment Plan

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The principal activities during 1997 focussed on planning for the pilot experiment, to be conducted at Duck, North Carolina in November of 1997. One of the activities was construction of the experiment plan for the pilot field program (Sun et al., 1997). This plan details not only the pilot experiment but also outlines the overall strategy of the multi-year effort.

b) Software Package for In-field Data Evaluation

Some attention was devoted to modification of the quality control program which will be used to isolate instrumentation problems in the field on a real time basis. The strategy is to analyze the aircraft data each evening using the quality control package as well as the package for flux sampling errors (Vickers and Mahrt, 1996). The latter will allow assessment of the soundness of the aircraft flight plan and allow modification of the flight plan for the subsequent flight the next day. Are the flight legs long enough or are the number of passes sufficient to adequately sample the flux? We feel that this real time analysis and the flexibility of the LongEZ crew will allow adjustment for mistakes that historically could not be corrected until the "next field program".

For analysis in the field, both ease and speed are critical. Therefore, a graphical user interface has been developed for point and click implementation of the quality control and flux sampling programs. This will allow timely review of the data each evening. At the writing of this report, we are concentrating on building an interface for simple scientific analysis of the data which will also facilitate in-field evaluation of the logic of the flight plan strategy.

c) Literature Survey

While the main internal boundary layer experiment will be carried out in 1999, we anticipate some internal boundary layer cases in the pilot experiment and hope to be able to carry out case study analyses of the internal boundary layer using data from the pilot experiment. A literature survey of internal boundary layer has been conducted concentrating mainly on observational studies. A manuscript is under preparation. These studies were carried out to anticipate development of internal boundary layers in offshore flow during the pilot experiment. Approaches for parameterization of the internal boundary layer height are:

a) surface based diagnostic formulations designed mainly in short fetch offshore situations on the scale of a few kilometers.

b) diagnostic formulations which include the influence of overlying stratification (or inversion strength).

c) mixed layer growth equations designed to model the growth of the internal boundary layer on the scale of tens of kilometers up to several hundred kilometers.

Present flight plans will capture horizontal scales which are relevant to all three of these approaches.

d) Remaining Problems for the Fall 1997 Experiment

Problems which remain to be solved in the next six weeks include:

a) Acquisition of the bi-directional spectral package for analysis of the laser data after Mark Donelan completes modification of this package.

b) Coordination of the usage of the LongEZ by Ken Melville for implementation of his wave imaging system. This coordination is behind schedule because of an extended illness suffered by Ken Melville.

c) Final testing and modification of the hardware for real time accessing LongEZ data. NOAA Oak Ridge will forward ZIP drives with data in the format identical to that which will be provided in the field and the final testing will be done at Oregon State prior to the pilot experiment.

d) Reconsider the accuracy of remote sensed sea surface temperature measurements which has been a difficulty in previous field programs for the LongEZ.

e) Choose dates for different air flow situations from previous Novembers for numerical simulation of air flow events at the North Carolina coast. Roger Pielke's group at Colorado State University is willing to run the RAMS model for us.

f) Our home page is being expanded to include the shoaling experiment.

RESULTS

The only products to date are the field experiment plan and a new software/hardware system for real time in-the-field quality control of data, evaluation of flux sampling problems and preliminary data analysis for evaluation of flight plan strategy.

IMPACT

The expected results from the fall 1997 experiment will eventually lead to improved modelling of the atmospheric boundary layer in the coastal zone which will be offered to operational Navy forecast models and models of radar propagation near the surface.

TRANSITIONS

None at this time.

RELATED PROJECTS

Analysis of offshore tower eddy correlation data is being carried out under grant N00014-96-0014 from the Office of Naval Research. This data allows analysis of detailed vertical structure

in the lowest 40 m (Vickers and Mahrt, 1997; Mahrt et al., 1997) whereas the above work concentrates on horizontal structure in the coastal zone.

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